Annual Report
Fiscal Years 2007-2008

DOD-DOE-FAA-NASA

Fall 2008

As of 10/19/2009

Submitted by PPSA Leadership Team

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EXECUTIVE SUMMARY

Traditionally, the Department of Defense (DoD), Department of Energy (DOE), Federal Aviation Administration (FAA), and the National Aeronautics and Space Administration (NASA) have separately developed and demonstrated new technologies for enhancing the operating safety, performance, affordability, and environmental compatibility of propulsion and power generation systems. A Memorandum of Understanding was signed in 2004 where the agencies agreed to improve coordination and collaboration in the areas related to propulsion and power systems, in anticipation that this would lead to greater national cooperation among the participants and stakeholders, and more effective leveraging of program funding. This provided the framework for the Propulsion and Power Systems Alliance (PPSA). The efforts of this alliance have led to more coordinated and integrated DoD/DOE/FAA/NASA program plans that achieve individual organizational goals and objectives, while maximizing investment synergy in areas of common need or interest. It will also lead to the broader application and more rapid transition of advanced propulsion and power generation technologies.

Intellectual collaboration is the basis upon which PPSA is formed and managed. The Leadership Team (LT) is comprised of senior managers from the member government agencies. The roles and responsibilities of the LT include providing the necessary senior leadership and direction to ensure that PPSA achieves its vision. PPSA, through its twelve Technology Area Teams (TATs), which are comprised of technologists and project managers from the member organizations, provides opportunities for government researchers in common areas of interest to regularly meet and exchange information on current research efforts. These interchanges form the basis to explore and plan more formal collaborations, designated as partnerships, where common objectives are defined, available resources from each partner are committed, and roles and responsibilities are delineated along with appropriate intellectual property agreements.

The impact of PPSA, in terms of adding value to the technology development and insertion processes, is measured and assessed using activity metrics (which count PPSA sponsored and supported activities that foster opportunities for collaboration) and accomplishment metrics (which measure the critical efforts that contribute to the prime outcomes or products of the various activities sponsored by PPSA). During this reporting period, ALL agencies benefited as shown by the 84 key accomplishments in this report. Some highlights include:

- DoD and DOE participated in the first NASA Combustion Technical Working Group Meeting.
- DoD, DOE, and NASA jointly evaluated proposals from several SBIR, STTR, and BAA solicitations (these topics were jointly coordinated).
- DoD, DOE, and NASA participation in each agency's peer reviews.
- Collaborations were expanded to other government agencies through coordination with the Interagency Advanced Power Group (IAPG).
- DoD and NASA are now working together to reduce emissions and noise including the 3rd NAVAIR Propulsion Workshop on Jet Noise Reduction December 10, 2008.
- DoD, DOE, and NASA have developed joint roadmaps for several materials areas.
- DoD, NASA, Industry, and Universities collaborated on turbomachinery forced response and provided new ideas for the consortium planning.

Turbine engine based propulsion and power systems play a critical role in our country's health, both commercially and militarily. If required technologies are to be developed and transitioned to the US user community in a timely fashion, collaboration between government agencies and with external organizations must become an even more important part of the technology development process. As this report demonstrates, PPSA clearly plays a leadership role in identifying, forming, and executing collaborative activities that will contribute to a strengthened technology portfolio.

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INTRODUCTION/OVERVIEW

Vision

The primary goal of the Department of Defense (DOD), Department of Energy (DOE), Federal Aviation Administration (FAA), National Aeronautics and Space Administration (NASA), and Propulsion and Power Systems Alliance (PPSA) is to:

"Improve propulsion and power systems technology program coordination and collaboration among government agencies, e.g., DoD, DOE, FAA, and NASA – leading to a greater national alliance/reliance among the program participants and, therefore, stakeholders resulting in more effective leveraging of existing federal investments in aerospace propulsion and power research and technology."

As the vision statement indicates, PPSA is a Federal government agency centered activity. However, PPSA does openly encourage industry and university participation on a case-by-case basis where the non-government partner's contribution would be critical to the success of a specific collaborative effort.

Collaboration Model

The collaboration model being utilized by PPSA is shown in Figure 1.

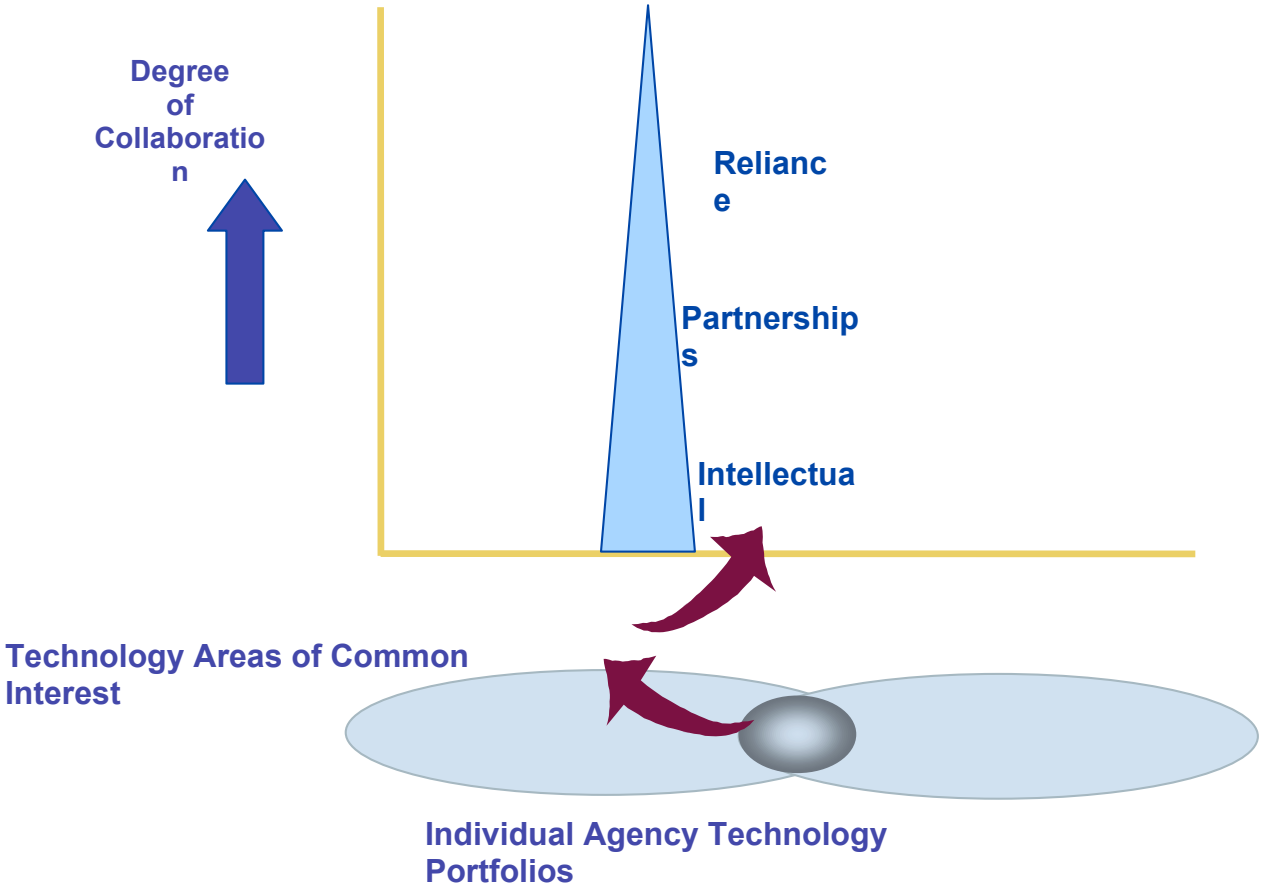

Figure 1. PPSA Collaboration Model

Intellectual collaboration is the basis upon which PPSA is formed and managed. PPSA provides opportunities for government researchers in common areas of interest to regularly meet and exchange information on current research efforts. These interchanges form the basis to explore and plan more formal collaborations designated, as partnerships where common objectives are defined, available resources from each partner are committed, and roles and responsibilities are defined along with appropriate intellectual property agreements.

Partnerships are a shared risk, shared reward effort. Opportunities will occasionally be determined where one agency could choose not to pursue a required technology area as it is being developed by another agency (or agencies). These relationships are defined to be dependencies. Obviously, the higher up one goes in the collaboration triangle, the greater degree of trust which must exist.

Organizational Structure of PPSA

The current organizational structure of PPSA is shown in Figure 2.

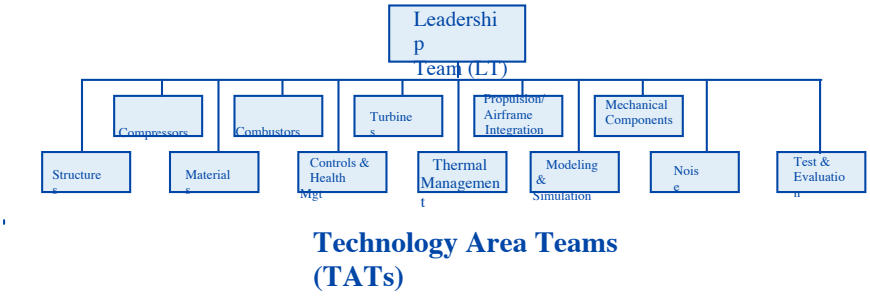

Figure 2. Current PPSA Structure

The Leadership Team (LT) is comprised of senior managers from the member government agencies. The roles and responsibilities of the LT include providing the necessary senior leadership and direction to ensure that PPSA achieves its vision. The LT is led by a chairperson selected from the current LT membership. The chairperson normally serves a two-year term.

The PPSA currently has twelve Technology Area Teams (TATs), which are comprised of technologists and project managers from the member organizations. The TATs are critical to the success of PPSA as they identify, plan, and execute specific collaborative efforts. Currently, PPSA TATs are:

Combustors
Compressors
Controls and Health Management
Materials
Mechanical Components
Modeling and Simulation
Noise
Propulsion/Airframe Integration
Structures
Test and Evaluation
Thermal Management
Turbines

As the listing of TATs indicates, the current emphasis in PPSA is on technologies that are required for future turbine based propulsion systems across the speed range (subsonic through hypersonic) as well as for future ground power systems which incorporate turbine systems.

The number of TATs can change from time to time as new areas are identified that seem opportune for collaborative opportunities or areas are de-emphasized and no longer appropriate for collaboration.

Each TAT has developed its vision in the following statements:

Combustors: The Combustors TAT vision is to be the recognized source of technological knowledge and research for combustion issues of mutual interest to DoD/NASA/DOE/FAA programs.

Compressors: The Compressors TAT investigates technologies that will improve the operability, durability, and efficiency of gas turbine engine compression systems. Advances are also pursued to increase the per-stage loading capability of compression systems without negatively impacting efficiency of operability. The members of the Compressors TAT are interested in a wide range of different technologies that are driven by the vehicle requirements of the various organizations. The Compressors TAT seeks to identify areas in which multiple agencies share interest in developing a particular technology, and then work collaboratively to advance the state of the art in that area.

Controls and Health Management: Controls and Health Management TAT's goal is to collaborate on the development of gas turbine engine control systems and components and engine health management, including sensors, electronics, software and algorithms. We work closely with other technology area teams to understand emerging control system requirements, assess and extend component life, and advance active engine component control.

Automated engine health management is a priority, to increase safety and readiness and enable adaptive engine control. Our vision is the convergence of state awareness, model based diagnostics and control with the increasing integration of propulsion, power (auxiliary and electrical), flight control, thermal management, and human factors to deliver intelligent propulsion and power systems. Since instrumentation for gas turbine research and development may evolve into engine control and monitoring sensors, cooperation in instrumentation developments is ongoing.

Materials: Advanced turbine engines will continue to demand improvements in a wide variety of materials with higher temperature capability, lighter weight and durability. There are numerous opportunities for collaboration among DoD, NASA GRC, and DOE researchers on the following:

-polymer matrix composites
-superalloy and other advanced blade and vane candidate materials
-power metallurgy disk superalloys
-ceramics and ceramic matrix composites
-advanced protective environmental and thermal barrier coatings
-shape memory alloys and piezoelectric ceramics

Mechanical Components: The Mechanical Components TAT focuses on coordination of technologies and programs that enable improvements in mechanical components for turbine engines and drive systems. Areas of mutual interest include turbine engine mainshaft bearings, lube system, sump seals, secondary air seals, and engine and rotorcraft gear and drive systems. The Mechanical Components TAT seeks to identify potential collaborative opportunities amongst PPSA agencies with the end goal of meeting increased propulsion performance demands without compromising mechanical system reliability and safety.

Modeling and Simulation: The Modeling and Simulation TAT focuses on technologies that enable improvements in the design, development, and operation of advanced systems. These improvements result in lower development time and cost and in lower risk for infusion of advanced technology. Specific technologies of interest include but are not limited to multi-fidelity system simulation (e.g., zooming), capability based analysis, advanced scientific visualization, cost modeling, collaborative engineering environments, and high performance computing platforms for engineering analysis. It is assumed that modeling and design tools specific to components and subsystems are considered by those

respective TATs. Due to the breadth of the topic, the TAT will also identify technologies that will impact future propulsion and power systems but are outside the scope of the other TATs.

Noise: The Noise TAT started in 2005 and is focused primarily on coordinating engine noise research across government agencies, and advocating for future work. Members include NASA, Air Force, Navy, and the FAA. One of the objectives is to leverage resources across government organizations to identify noise reduction technologies that can benefit military high performance and transport aircraft. The TAT provides a mechanism to raise awareness of work across a wide range of government sponsors. Solutions for noise reduction are sought that include source noise reduction from the propulsion system and flight operational procedures that can minimize community noise impact. Since most of the noise reduction research supported in the past has been aimed at commercial aviation, applying the technologies to military aircraft are met with limited success due to different requirements. The major noise source for high performance aircraft is the jet noise radiating from the high velocity hot exhaust. Jet reduction remains a challenge for this application due to the need to maintain high performance. For transport aircraft, solutions for commercial engines are easier to implement and in many cases have common engine components.

Propulsion and Airframe Integration: The Propulsion Airframe Integration TAT is focusing on coordination and cooperation in technology areas of inlet-airframe, nozzle-airframe, inlet-engine and nozzle-engine integration that are of mutual benefit to the participating organizations. Current areas of common interest consist of advanced inlet flow control, including sensors, actuation systems and effectors, as applied to inlet-engine systems and structurally integrated exhaust systems with fluidics technology for area and vector control. It is our desire to have these activities tied together with a TAT roadmap to indicate ongoing and planned efforts as well as potential technology "gaps" where additional investment may be warranted.

Structures: The Structures TAT strives to coordinate projects and activities across agencies to effectively use limited resources towards common goals and prevent duplication of effort. These goals include maximizing safety, reliability, and performance through improved structural performance. The minimization of operating costs is also of great interest.

Implementation Strategy: To meet these goals, the team attempts to engage the key players within the respective agencies in technical activities across agencies to provide consultation, leverage the products of those activities, and assure smart investments in their respective areas. The team oversees a significant breadth of R&D among academia, small businesses, and industry. Moreover, there is also a large technical arena generated by our agency programs, e.g., High Cycle Fatigue, VAATE, etc. The team reviews areas of collaboration among these groups and tries to build programs which have the highest opportunity to transition to a current commercial or military development programs. These programs continue to have a need for new structural design and analysis tools and technologies to meet their goals.

Test and Evaluation: Will improve propulsion and power systems testing technology development through coordination and collaboration. The technology area includes hardware, software, and techniques used to acquire, condition, reduce, and validate data in support of ground/flight developmental and operational testing of turbine engines and components. Topics include but are not limited to instrumentation and control, information technology, computer aided modeling and simulation, test facilities and hardware, test planning, and operator training. Toward this end, the team will leverage existing federal investments in aerospace propulsion and power research and testing. This team will operate in cooperation with other technology area teams who share interests.

Thermal Management: The Thermal Management TAT utilizes a multidisciplinary systems approach to assess and manage the heat loads of the aircraft, aircraft subsystems, propulsion system and additional heat generated by the payload and/or environment. Creates awareness to base components (compressors, turbines, combustors, nozzles, etc.) and subsystems (fuels, ECS, avionics, electronics,

actuators, etc.) to minimize heat loads and increase temperature capabilities. Acquires and manages knowledge/awareness of thermal management activities across participating organizations (i.e., IAPG, et al) to identify effective collaborative opportunities.

Turbines: The Turbine TAT investigates technologies that will improve the operability, durability, and efficiency of turbine systems. Investigations into increasing stage loading and decreasing required cooling flows for the turbine system without adversely affecting efficiency or operability are of interest. Experimental and computational research methods are used to further the turbine component state of the art. The Turbine TAT seeks to identify potential multi-agency collaborations, which would advance turbine technologies toward transition into future engine systems.

Business Practices

The current business practices of the PPSA are as follows:

Annual Meeting: Each year the PPSA LT plans and executes a multiple day meeting that provides an opportunity for the individual TATs to meet and conduct business as well as meet with other TATs where cross functional collaboration opportunities can be explored. Each TAT is also asked to report out to the LT emphasizing the topics of status, opportunities, and issues for that particular TAT. At these meetings, the LT invites external organizations, which might have collaboration opportunities, to present appropriate overviews in a plenary session. In addition, the LT invites speakers to give featured presentations on various aspects of the collaboration process. This annual meeting also provides an opportunity for the LT to have closed sessions to devote to overall PPSA business.

Monthly telecons: Each month the LT has a one- to two-hour telecon to discuss appropriate PPSA business as well as hear an update from selected TATs. A schedule for these telecons is developed by the Executive Secretary such that each of the TATs has one session with the LT each quarter. It is believed that these brief but regular interactions have improved communication between the LT and TATs and improved the collaborative activities being conducted by PPSA.

LT mid-year meeting: Each February, the LT conducts a one half-day closed session to conduct appropriate business. Typically this meeting is planned to occur the day before the DOD VAATE Steering Committee meeting in Washington, DC.

Web site: PPSA has an operational publicly available web site: **https://ppsa.grc.nasa.gov**. The web site is used to communicate the PPSA story to external individuals and organizations as well as provide opportunities for organizations to recommend collaboration opportunities to PPSA.

Reports: Every other year the PPSA writes an overview report on status and accomplishments of PPSA. This is a publicly available report but is primarily intended for key stakeholders.

Metrics: The impact of PPSA (in terms of adding value to the technology development and insertion processes) should be measured and assessed using appropriate metrics. The metrics being employed are of two types - activity and accomplishment. As the title suggests, *activity metrics* are those which count PPSA sponsored and supported activities which should foster opportunities for collaboration. *Accomplishment metrics* measure the critical efforts that contribute to the prime outcomes or products of the various activities sponsored by PPSA. Currently, the PPSA metrics are:

Activity Metrics

Technology exchange meetings/telecons held since annual meeting
Invited technology exchange presentations since annual meeting

Accomplishment Metrics

Collaboration working groups established since annual meeting
Formal/informal collaboration agreements established since annual meeting
Partnership efforts initiated since annual meeting
Reliance agreements (formal/informal) established since annual meeting
Collaboration efforts successfully completed since annual meeting
Collaboration efforts terminated since annual meeting.

OVERVIEW OF RECENT ACCOMPLISHMENTS

This report covers the period of FY2007-2008.

Leadership Team, Joe Shaw, NASA Glenn, served as Lead, Leadership Team, during FY07-08

1. Continued to develop a closer collaborative relationship with the Interagency Advanced Power Group (IAPG) to ensure that needed collaborations are developed related to turbine engine based power systems and to avoid duplication of effort.
2. Worked closely together in development of SBIR topics and evaluation of proposals to ensure maximum return on investment and reduce duplication of effort.
3. Continued to refine PPSA business practices to improve organization's efficiency and activities so as to lead to improved future products.
4. Continued development of a web site to serve as an education/outreach tool for PPSA.
5. Planned and conducted PPSA annual meetings which includes speakers from government funded, university based research activities that are relevant to the PPSA charter and could provide opportunities for collaboration.

Combustors TAT, Peter Strakey, DOE, National Energy Technology Lab, Lead

1. NETL and AFRL participated in the first NASA Combustion Technical Working Group Meeting (held in conjunction with AIAA Reno Meeting, January 08).
2. Increased collaboration in Inter-Turbine Burner efforts between multiple agencies. Army OSD Phase II Inter-Turbine burner kickoff meeting hosted at AFRL. Attendees included AF, Army, Navy, NASA.
3. Improved involvement with fundamental combustion efforts. NASA, Army and NETL participated in recent AFOSR contractors propulsion review meeting (June 08, Arlington, VA).
4. NETL and AFRL have increased involvement with MACCCR group. Cyber Infrastructure study for combustion research underway (NAS).

Compressors TAT, Gregory Bloch, AFRL, WPAFB, Lead

1. Joint (AF, Army, NASA) evaluation of 15 SBIR proposals for advanced high-speed, large-diameter, low-leakage seals; 1 selected for AF funding
2. Joint (Army, AF) evaluation of AATE engine technology demonstrator engine proposals; 2 contracts awarded for combined value of $70M PLUS industry cost share
3. Joint (AF, Army, Navy, NASA, DARPA) evaluation of ADVENT technology demonstrator engine proposals; 2 contracts awarded for combined values of $524M, including cost share
4. Joint (AF, Army, Navy, NASA) evaluation of HEETE compressor technology development contracts; 2 contracts awarded for combined values of $39M including cost share
5. Joint (DOE, AF, Navy) review of RAMGEN novel compressor concept to support coal-fueled stationary power plants

6. Joint (AF, Army, Navy, NASA, DARPA) review of turbine engine OEM Advanced Technology Program Plans
7. Joint (Air Force, Navy, Army) support of ADVENT Integrated Baseline Reviews and Preliminary Design Reviews
8. Joint (Air Force, Army, Navy) support of HEETE Preliminary Design Reviews

Controls and Health Management TAT, Al Behbahani, AFRL, Lead
Richard Millar, Navy, 2007-2008 Lead

1. Joint (USAF/ NAVAIR /ARMY) collaboration on Safety and Affordable Readiness (P-SAR) Program Formulation
    1. Proactively Ensure Propulsion Safety and Affordable Readiness Through Emerging Sustainment Technologies by: (1) Safety – Reduce propulsion related Class A mishaps by 75%, (2) Affordability – reduce maintenance costs by $420M (10%), and (3)Readiness – Increase Average Time on Wing (ATOW) by a factor of two (2X).

    2. Respond to Integration, Transition & Implementation team

2. Joint (NAVAIR / USAF/ UK Ministry of Defence (MOD) collaboration on US/UK Program Agreement on the following: Military Engines Reliability & Safety (MERS)
    1. Focused on PHM System Demo for Short Takeoff And Vertical Landing Aircraft (STOVL) F-35 LiftFan and LiftFan drive
3. Joint (NAVAIR and AFRL) collaboration on controls and Prognostics & Health Management (PHM) for F-35 Reconstruction for VAATE and SBIR programs
4. Joint (all government and industries) collaboration on Advanced Intelligent Adaptive Affordable Distributed Modular Propulsion Controls for the future (Distributed Engine Control Working Group (DECWG) / Propulsion Instrumentation Working Group (PIWG)/ Aeronautics Sensors Working Group (ASWG): Collaboration between AFRL and NASA
    1. Distributed Intelligent Control (All)
        - Smart Sensors and Open Systems Sensor Suite
        - Universal / Distributed FADEC System Components/Platform
        - Generic Electronic Module
        - High Temperature Capability
        - Smart Actuation Systems
    - Analysis of Alternative (AOA) Sensors and Instrumentation (All)
5. Modeling and Simulation for Gas turbine engine and Controls
    - Joint Collaboration (TSU, OSU, UC, AVETEC, AFRL, NASA, original equipment manufacturer or original engine manufacturer (OEM) and Airframers)
    - Integration with TMS and Power (AFRL(Propulsion and Power with collaboration from AVETC and NASA)
6. Joint SBIR Coordination and Collaboration (AFRL/NASA/NAVAIR)
    - Distributed Controls smart sensors (NAVAIR/AFRL/GE)
    - Fiber Optic Research (AFRL / NAVAIR/ P&W)
7. Joint Collaboration (AFRL/NAVAIR) on Adaptive Versatile Engine Technology (ADVENT)/ Highly Efficient Embedded Turbine Engine (HEETE) Operability & Supportability: Model Based Diagnosis/Model Based Prognostics/Performance Based Logistics/Model Based Control/ Life-Extended Control/Model-Predictive Controls
8. Joint Collaboration (AFRL/NASA) on Active Combustion Control System (ACCS)
9. Collaboration between two Branches within AFRL (RZTS/RZTC) Joint Collaboration with AFRL/ Goodrich/Parker/OSU/Stanford/GIT/Spectral Sciences on ACCS
    - Mide Technology and GE Aviation
    - Goodrich and GE Aviation

- Parker and Pratt & Whitney

10. Joint Collaboration (AFRL/ GE/ Stanford) on PHM Algorithm Development
11. Joint Collaboration (Intelligent Automation Corporation now is part of Honeywell (IAC)/Honeywell /AFRL/NASA/Hamilton-Sundstrand, P&W, Boeing) PHM Generic Propulsion Health Management for vibration and integrate oil debris monitor with vibration for Joint Strike Fighter (JSF) engine bearing health monitoring
12. Joint Collaboration (AFRL/P&W/SBIR) on PHM Hardware Development
13. Joint Collaboration (Notre Dame /NAVAIR/AFRL) on Advanced Sensors
14. Joint Collaboration (AF, Army, Navy, NASA, Defense Advanced Research Projects Agency (DARPA)) on Fuel Pump Development: evaluation of ADVENT technology demonstrator engine proposals; 2 contracts awarded
15. Joint Collaboration (USAF, and Army): Evaluation of VAATE Broad Agency Announcement (BAA) plan and our Focused Long Term Challenge (FLTC)/Advanced Technology Development (ATD) commitments.

Materials TAT, Mary Anne Alvin, DOE NETL, Lead
Ajay Misra, NASA Glenn, 2007-2008 Lead

1. Initiated joint NASA/AF development of an advanced disk system with 1400ºF (NASA goal 1500ºF) system. This included joint procurement of a large disk. Properties to be evaluated jointly. Jointly planned development of hybrid disk with 1500ºF capability. Workshop on hybrid disk held.
2. Several managers from the Structures and Materials Division at NASA visited AFRL to discuss areas of collaboration. Identified several areas of collaboration, including disk and CMC. Planned to develop joint roadmaps.
3. Joint NASA/AFRL development of CMC blade. AFRL funded NASA to transfer technology to Goodrich.
4. Several NASA/AF meetings conducted on green propulsion planning. AF management presented to Fundamental Aeronautics program management at NASA HQ.
5. Development of NiAlPt alloys; Thermochemical property measurements conducted (NASA/AF).
6. NASA/AF participated in evaluation of proposals funded by the other organization.
7. NASA participated in review of NETL yearly progress on advanced coating systems.

Mechanical Components TAT, Lewis Rosado, AFRL, WPAFB, Lead

1. Completed foil bearing coating screening tests for small engine (Air Force/Navy/NASA)
2. Jointly formulated New start effort under Timken cong add on gear & drive systems technology (Army/Air Force)
3. Established new limits for elastomer seals-oil compatibility under Joint Enhanced Ester Program (Air Force/Navy/Industry)
4. Continued successful partnership on Joint Enhanced Ester development, nearing oil down selection for JSF (Air Force/Navy)
5. Advent proposal tech eval (Air Force/Navy/NASA)
6. SAE E34 Aerospace Lubricants committee meetings held (Navy/Air Force/Industry)
7. Bearing Modeling Summit held – Jul 07 (Air Force/NASA/Industry)
8. Continued successful collaboration on advanced gear technology between Army and NASA (Highlights include face gear durability and single tooth testing of laser shock peened gears)
9. Joint Army/NASA technical review and monitoring of GE foil bearing development for small helicopter turboshaft engines

Modeling and Simulation TAT, Tom Lavelle, NASA Glenn, Lead

1. Completed simulation of advanced adaptive engine cycle. Work was documented in JANNAF paper, "System Level Benefits of a Turbofan Propulsion System Equipped with an Independently Modulated Auxiliary Stream", Simmons, Kuprowicz. (NASA/Air Force)
2. Defined relationship between US government and NPSS Consortium (NASA/Air Force)
3. Help guide development of NPSS/Model Center plugin (NASA/Air Force)
4. Transferred NPSS Simulink Capability from NASA to Air Force (NASA/Air Force)
5. Exchanged information on NASA and Air Force cost analysis tools

Noise TAT, Dennis Huff, NASA Glenn, Lead

1. The FAA and NASA are collaborating on defining requirements for a proposed FY09 program called "CLEEN" (Continuous Low Energy, Emissions and Noise)
    - FAA funding requested in President's FY-09 budget for program start.
    - Focused on reducing current levels of aircraft noise, local air quality and greenhouse gas emissions and energy use and advancing alternative fuels for aviation use.
    - Technology demonstration at a developmental level that will allow quicker industry uptake.
2. NASA and Navy shared reviewers for SBIR proposals.
3. F-35 noise tests completed included several legacy aircraft for baseline comparisons.
4. Air Force started construction of Aeroacoustic Research Complex (ARC) for flight tests, includes 300' towers for microphones to provide directivity measurements.
5. Navy, NASA, industry and university representatives participated in jet noise workshop at PAX River in November 2007 to review progress and identify candidate technologies ready for higher TRL.
6. Navy sponsored tests with GE on F404-400 engine with chevron nozzles, results show ~2.5 dB noise reduction with fixed chevrons, no measurable thrust loss.
7. NASA initiated a twin jet noise study as a part of the Fundamental Aeronautics Supersonics project, will investigate jet plume interactions for rectangular nozzles.
8. SERDP (Strategic Environmental Research & Development Program) for Air Force: GE model scale nozzle of 414 engine delivered to NASA, will test for acoustic comparisons with full scale jet noise data and flight data from F-15. Noise reduction methods will be investigated next year (including chevrons).

Propulsion/Airframe Integration TAT, Raymond Ball, Navy, Lead

1. Coordination meeting conducted at NASA Langley, VA with presentations from Susan Gorton – *NASA Subsonic Rotor Wing Project Overview* and David Whitte – *NASA Turbine Base Combined Cycle (TBCC) Inlet Tests.*
2. Conducted successful Shock-Wave Boundary Layer Interaction Workshop coordinated jointly by NASA and Air Force (April 2008) with over 70 in attendance.
3. Coordinating the STTR program for high speed inlet design between NASA Glenn and the Navy.
4. Reviewing NASA SBIR topics on rotorcraft technology for possible collaboration.

Structures TAT, Bill Stange, AFRL, WPAFB, Lead

1. Continued successful collaboration on turbomachinery forced response through the GUIde III consortium (NASA/AFRL/AFORSR/USN/Industry/Universities). PPSA provided opportunity for new ideas for GUIde IV consortium (NASA/DOD) planning.
2. Continued two collaborations on developing and testing composite fan containment case (NASA/ A&P Technology).

3. Continued successful collaboration in three turbo-electric propulsion system studies (NASA/Georgia Tech URETI). PPSA connected NASA turbo-electric work with URETI.
4. Continued collaboration on PSAR Action Teams. PPSA enables PSAR to incorporate a wider range of technologies.
5. Collaborated on VAATE BAA proposal Evaluation.

Test and Evaluation TAT, Mike Barga, AFRL, WPAFB, Incoming Lead

This TAT is in the process of being reactivated under the leadership of Mike Barga. A new vision was developed at the 2008 PPSA meeting.

Thermal Management TAT, Jeff Brown, AFRL, WPAFB, Lead

1. Continued coordination with M&S Technology Area Team in development of improved systems level thermal models -- Using the recently NASA to Air Force transferred NPSS Simulink Capability as critical part of integrated thermal management system and engine link for the system level analyses (NASA/AF)
2. Coordination with mechanical systems technology area team to ensure realistic TMS heat loads/sinks resulting from successful partnership on Joint Enhanced Ester development, nearing oil down selection for JSF (AF/Navy)
3. Coordination with on-going mechanical systems work on foil bearing coating (friction impacts thermal) screening tests for small engines (AF/Navy/NASA)
4. Coordination through controls technology area team on thermally efficient fuel pump development efforts (AF/Navy /Army)
5. Joint (AF, Army, Navy, NASA) coordination of 3 Phase I heat exchanger M&S SBIR's; evaluations in September 2008 for Phase II funding
6. Joint (AF, Navy) evaluation of TMS related to ADVENT technology demonstrator engine proposals; 2 contracts awarded for combined values of $524M, including cost share
7. Joint (AF, Navy) evaluation of TMS related to HEETE compressor technology development contracts; 2 contracts awarded for combined values of $39M
8. Joint (AF, Navy) evaluation of TMS related to INVENT subsystem integration and technology development proposals; selection to occur in September 2008
9. Joint (AF, Army, Navy, NASA) review of turbine engine OEMs'Advanced Technology Program Plans related to thermal management

Turbines TAT, Jim Heidmann, NASA Glenn, Lead

1. Led organization of 160 turbine heat transfer papers at Berlin ASME Turbo Expo (NASA/Air Force)
2. Low pressure turbine (LPT) flow control technologies developed under NASA NRA using L1A LPT design from John Clark of AFRL (NASA/Air Force/Universities)
3. Continued discussions with AFRL on ADVENT and HEETE Program turbine and compressor needs, and with the FAA on the CLEEN Program (Air Force/FAA/NASA).
4. Planned upcoming Honeywell cooled turbine experiment at The Ohio State University (NASA/Honeywell/OSU)
5. Developed turbomachinery white papers for top technical needs under Subsonic Fixed Wing Aerothermodynamics Technical Working Group (NASA/Air Force/GE/P&W/Honeywell/Universities)

CONCLUDING REMARKS

Turbine engine based propulsion and power systems play a critical role in our country's health both economically and militarily. Nevertheless, future Federal government investments in technologies relevant to turbine engine systems are forecast to, at best, remain level for the foreseeable future. If required technologies are to be developed and transitioned to the US user community in a timely fashion, collaboration between government agencies and with external organizations must become an even more important part of the technology development process. PPSA has an opportunity to play a leadership role in identifying, forming, and executing collaborative activities that will contribute to a strengthened technology portfolio.

The most recent accomplishments of the organization as described in this report suggest progress is being made towards the PPSA vision.

PPSA welcomes any/all feedback on this report. Responses should be sent to the current chairperson of the Leadership Team William Koop (william.koop@wpafb.af.mil). PPSA also encourages interested persons to utilize our website (https://ppsa.grc.nasa.gov) for additional information on our organization.

DEFINITION OF TERMS/ACRONYMS

AATE: Advanced Affordable Turbine Engine

ADVENT: Adaptive Versatile Engine Technology

AFRL: Air Force Research Laboratory

ASME: American Society of Mechanical Engineers

CLEEN: Continuous Lower Energy, Emissions and Noise

CMC: Ceramic Matrix Composite

DoD: Department of Defense

DOE: Department of Energy

FAA: Federal Aviation Administration

GE: General Electric

HEETE: Highly Effective Embedded Turbine Engine

IAPG: Interagency Advanced Power Group

LT: Leadership Team

LPT: Low Pressure Turbine

NASA: National Aeronautics and Space Administration

NPSS: Numerical Propulsion System Simulation

NRA: NASA Research Announcement

OEM: Original Equipment Manufacturer (a turbine engine manufacturer)

P&W: Pratt & Whitney

PPSA: Propulsion and Power Systems Alliance

RAMGEN is the name of a company.

SBIR: Small Business Innovative Research

STTR: Small Business Technology Transfer

TAT: Technology Area Team